MANAGING SWINE REPRODUCTION

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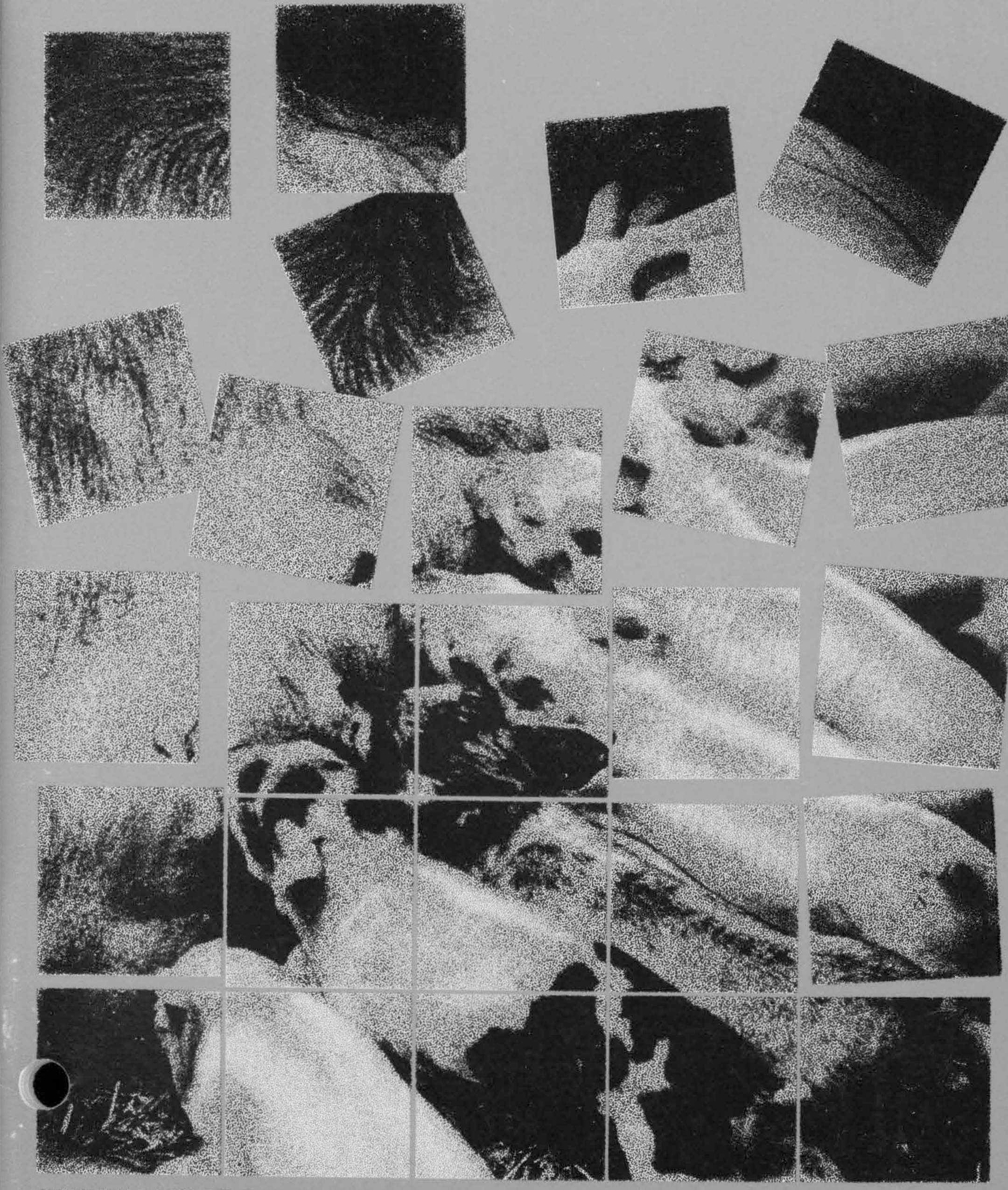

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Preface

During the past 20 years, there have been significant improvements in swine nutrition, housing, waste management, and mechanization, but little progress has been made in increasing reproduction. Unfortunately, there are no quick and easy solutions to improving reproductive performance. The only solution (and it is a long-term one) is to follow sound management practices and a rigorous selection program for fertility and litter size.

Managing Swine Reproduction *was written to provide pertinent information about reproductive management for producers, managers, herdsmen, veterinarians, consultants, Extension advisers, teachers, students, and others concerned with swine-production systems. It contains sections dealing with the selection of replacement animals of both sexes from birth to farrowing; the flow of replacement animals into the breeding herd; the management of boars; the practical application of the techniques of fertility testing and artificial insemination (AI); and the causes of reproductive failure.*

An extensive glossary and detailed drawings of the reproductive tracts of male and female swine have been included to help clarify many of the terms and concepts discussed in this publication. I wish to thank A. H. Jensen and G. R. Hollis of the Department of Animal Science for reviewing the manuscript and offering helpful suggestions.

L.H.T.

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The process of reproduction is extremely complicated and involves many highly specific biological functions. The external environment (diet, housing, social surroundings, temperature, disease, etc.) has a far greater influence on reproductive performance than on any other biological process because the newborn of any species require special protection from environmental extremes. The mammalian mother must maintain herself, as well as provide nutrients, warmth, and protection for her young. She must be sensitive to both the existing and the future environment.

Wholesale application of various hormones to control reproductive processes in domestic animals without considering the physiological capacity of these animals will not solve reproductive problems. Positive results are more often the exception than the rule because the body does not always respond favorably to unnatural biological conditions that are forced upon it.

The gradual adaptation in swine to a total-confinement environment indicates that selection must be involved in this adaptation. Reproductive performance is no exception. The higher rates of reproductive performance are probably not wholly natural even in litter-bearing animals like swine. Management and selection must be used to *create* an environment that enables swine to express their reproductive potential, and we must develop new means of determining reproductive potential in order to propagate the more prolific lines.

The management program and associated environment play significant roles in reproductive performance, as well as in the reliability of determining the reproductive potential of the breeding herd. Breeding systems range from pasture breeding and annual farrowing to total confinement (which may include artificial insemination, embryo transfer, and continuous farrowing). Each breeding system is effective only within the limits of the management program and the environment. No particular breeding system or management program is best for all producers, and no single change in management can so completely revolutionize a process as complex as reproduction as to eliminate all of the problems. There is, however, no substitute for sound management.

Selecting and Developing Breeding Stock

The reproductive performance of the breeding herd determines the rate of animal turnover, directly influencing the economic status of the production unit. Reproductive performance is most critical in swine managed in confinement because of the large capital investment in facilities. There have been few advances in reproductive performance, however, despite improvements in nutrition, management, housing, disease control, etc.

Muscling, growth rate, and leanness have been the primary criteria for selecting breeding animals over the past two decades. Less emphasis has been placed on traits actually related to reproductive performance. Crossbreeding has been used to solve breeding problems, and no attempt has been made to manage potential replacement gilts as anything other than market hogs for the first six months of life. Breeding animals must be identified for their prospective roles long before their potential is expressed, but no method has been used for selecting possible breeding animals other than visual appraisal — a process that carries with it a large margin of error.

As the swine industry moves toward total confinement of all breeding and market animals, turnover rate as well as the predictability of reproductive events become critical in scheduling the use of facilities. Producers are using the "all-in, all-out" system, in which a group of females is farrowed during one week or less, their pigs are weaned on the same day after a three- or four-week nursing period, and all sows are moved out of the farrowing barn. This system allows for more thorough cleaning of the farrowing facility than continuous farrowing and reduces the number of pig deaths from disease. Since the gestation period cannot be altered significantly, females must be bred within less than one week of one another if they are to farrow within the same week at the end of normal gestation.

One of the major problems in managing the breeding herd is obtaining enough replacement gilts that will cycle and conceive to fill a breeding group during a specified period of time. Most producers solve this problem by moving two or three times as many gilts from the finishing facilities as are actually required. Before an adequate number of gilts are pregnant, an even greater number of gilts that do not cycle or that breed late are held for an excessively long period, and are usually too heavy (250 to 300 pounds) to be in the desirable market-weight range. In addition, the investment cost is considerably higher for the gilts that were kept as replacement animals.

These practices are now being questioned, and many producers are being forced to reevaluate their programs. The results of some recent studies may help you to select and develop more efficient breeding animals.

The first problem is the age at which gilts attain puberty. The gilt must reach puberty and conceive before she can produce a litter. Results from research at the University of Nebraska indicate that age at puberty is fairly heritable, and that selection in both the boar and sow can be effective in reducing age at puberty in replacement gilts. Gilts that show estrus early also mature physically at a younger age. They are prone to producing less desirable carcasses containing slightly more fat, indicating that selecting for extremes in muscling and fat covering are not necessarily advantageous to reproductive performance.

In a study at Texas Tech University involving over 1,300 gilts, the reproductive performance of gilts farrowing at 10 and one-half months or earlier was equal to that of gilts farrowing at older ages. Gilts that farrowed earlier experienced no greater farrowing problems, raised as many pigs, and "bred back" (rebred) as soon and as regularly as gilts that were bred later. This study indicates that younger replacement gilts should be selected and bred by at least six and one-half to seven months of age. Late-maturing gilts will be automatically culled when the age at which replacement gilts must be bred is reduced.

An Iowa State University study showed that extremely meaty hogs possessing little fat are prone to the Porcine Stress Syndrome (PSS), and that both males and females are much less fertile. These gilts reach puberty at a later age and produce smaller litters. The boars lack libido, and are not as fertile as those not prone to PSS.

Swine producers are most concerned about the size of litters farrowed and weaned. The Texas Tech University study showed that sows that farrowed large litters as gilts were most prolific in subsequent litters. The size of the first litter was the best indicator of reproductive potential if nine or more pigs were born. This trait is easily measured and is quite reliable.

Researchers at the University of Nebraska found that ovulation rate is fairly heritable. An accurate method of determining ovulation rate would allow producers to select gilts with a greater potential to produce large litters. Studies conducted at the University of Illinois have shown that blood levels of certain hormones reliably indicate ovulation rates. High ovulation rates, however, do not necessarily guarantee large litters.

The environment in which pigs are reared is critical even during the first month of life, and can actually prevent gilts from expressing their genetic potential. Studies at North Carolina State University indicate that gilts reared in large litters did not necessarily become good producers when they entered the breeding herd. Modifying the environment by confinement has also been shown to delay puberty, suggesting that environment is probably more important than genetic background in determining the reproductive performance of females. **You must adjust your management program to improve the environment for rearing replacement gilts.**

These studies indicate that reproductive performance can be improved through selection and management. There are basically two goals: (1) to produce replacement animals for the breeding herd; and (2) to produce a market hog of excellent carcass quality and feed efficiency. To attain the first goal, you must select a small number of boars for their ability to sire sound, prolific daughters (a gilt line). To attain the second, you need a larger number of boars to sire offspring that grow faster and yield more meat. These boars will be used in a terminal cross (all offspring to be slaughtered).

In current breeding systems, two or three breeds are selected that complement one another in productive traits. The most popular three-breed cross involves Hampshire for muscling and growth rate, Duroc for growth rate and acceptable litter size, and one of the white breeds (usually Yorkshire) for mothering ability, ease of breeding, and superior litter size. Other breeds have also been used successfully. There is probably more variation within any one breed than there is between breeds of swine today — and we must crossbreed. The goal is to "amplify" the traits of low heritability through crossbreeding so that the female possesses a maximum amount of hybrid vigor. After that point, it pays to maintain hardiness and gaining ability of the baby pigs by crossbreeding with a third breed.

First, we need to determine the number of replacement gilts required, and the age at which the gilts must be bred. Since about 30 percent of the breeding herd must be replaced after each farrowing, gilts from 30 percent of the litters will be required to obtain enough gilts that are pregnant at the correct age for the farrowing schedule.

The sows that will be bred to produce potential replacement gilts should be selected according to the number of pigs farrowed and weaned in their first litters, for soundness of feet and legs, and for teat number and proper functioning. An easy method for remembering the size of the first litter of any sow is to indicate the number of pigs on her card with an ink marker (if records are kept), or notch the end of one ear if she farrowed more than 10 or 12 pigs in the first litter. Use any simple method that works best for you.

Traits are influenced by both parents, and selection for any trait can be successful only if both parents possess superior genetic capabilities. Because boars do not exhibit maternal traits, they should be selected on the basis of the reproductive performance of *at least* their dams and granddams and the size of the litter in which their sires were farrowed. You should make every effort to obtain information about the sires of replacement gilts. Only a small number of animals is required if you have sufficient information about existing boars or sows. Do not be unduly concerned about size, muscling, or backfat thickness in the gilt-line boar. Evaluate his background as well as his feet and legs. Gilt-line boars should be mated to 20 to 30 percent of the sows in each farrowing group. As a good rule of thumb, the number of replacement gilts to be bred in this system should equal three times the number of sows culled.

When the selected sows have farrowed, all of the gilts should be identified as being the product of planned mating. Notch one ear to indicate the farrowing group for that year. Ear notching serves two purposes: (1) it designates a gilt as a potential replacement; and (2) it indicates her birthdate. The other ear can then be notched with part of the sire's number. Boar pigs from these litters may well become the future gilt-line sires. They should be identified in the same manner as the gilts.

Because the size of the litter in which a gilt is reared may be detrimental to subsequent reproductive performance, most (and in some cases, all) of the male pigs, especially the large male pigs, should be moved to a foster mother. The litter should be reduced to no more than six pigs. This practice (cross fostering) will provide a more desirable environment during the gilt's early development, and will allow her to grow more rapidly during the nursing period.

There are several advantages to reducing the size of the litter. Less time is required to keep records, and fewer pigs need to be identified at farrowing. The approximate birth date will be known, and gilts can be grouped by age in the nursery and finishing barn for more effective management and observation. The only record that needs to be maintained other than individual identification of females is the number of pigs farrowed by sows raising large first litters. This information can be indicated by a color-coded ear tag once the sow has farrowed and raised her first litter.

Gilts do not need to be limit-fed, but they should not be fat. If gilts do not cycle until they are eight or nine months old, they should be culled. The proper number of animals per pen and adequate space are critical to reproductive development. Some producers believe that solid plywood walls between pens help reduce the social stress believed to be associated with delayed puberty.

As gilts approach six months of age, they should be exposed to an aggressive boar for about 15 minutes daily. The purpose of this exposure is to check estrus (heat) — it is important economically to identify the gilts that mature and cycle at an early age. Boar exposure has been shown to induce estrus at an earlier age, reducing the man hours involved in checking estrus. Cycling gilts can then be bred, and the remaining noncycling gilts can be sold at a more desirable market weight. Feed costs will be lower, and gilts will be more productive because they farrow at younger ages. These benefits are in addition to the genetic progress that can be made in improving litter size.

Another approach should be taken with the young boars that are being developed to sire replacement gilts. More social experience during early phases of growth and development appear to prevent libido problems later. These young boars can be penned with market gilts during the growing stages — from nursery through the finishing barn. Young boars should not be isolated from females for long periods, but they should not be penned with mature sows.

How are the remaining sows (about 70 percent) to be bred? If they do not farrow large litters, their productivity has already been determined. Their only other purpose as long as they remain in the breeding herd is to produce market hogs. Sires to be used for breeding these females should be selected by conventional means to improve growth rate, feed efficiency, and carcass merit because that is their sole purpose. It is not important whether the boars are purebred or crossbred as long as they are highly fertile.

Gains in litter size and improved reproductive efficiency will require at least four or five generations, depending upon the history and performance of existing breeding animals. Once an efficient breeding system and management program have been developed, the cost in labor, feed, and facilities will be decreased. As progress is made, however, the rate of improvement in reproductive performance is reduced. The first two years should result in measurable benefits if poor-producing females and infertile boars are identified and carefully culled.

Summary

- Identify gilts from large litters.
- Reduce litter size by transferring males to other sows.
- Select or develop boars to sire more prolific gilts, and breed the highest producing sows to these boars.
- Breed medium- and low-producing sows to boars selected for traits (growth rate and carcass quality) more suitable for market-hog production.
- Manage gilts and boars to improve breeding efficiency and reproductive performance.

The Gilt Pool: The "Second String"

The "gilt pool" describes a group of young females that have been designated as potential brood sows. This portion of the breeding herd is probably the most overlooked and undermanaged, but it actually holds the entire program together. A number of sows will be culled after each farrowing period because of infertility, disease, age, lameness, size, etc. Maintaining the proper number of females in each breeding group (regardless of the type of operation) depends upon the introduction of replacement gilts.

The farrowing facility is not flexible. The number of stalls in a farrowing barn or the capacity of the farrowing facility, whether it is all-confinement or a pasture system, is largely predetermined. Labor and utilities are used most efficiently if a facility is operating at its designed capacity. Empty stalls in a farrowing barn because of inadequate numbers of replacement gilts result from mismanagement of the gilt pool.

Most producers maintain a group of gilts that have been selected as replacements. The main problem in using this gilt pool is that once the breeding season has been completed for any one group, animals that are bred later cannot be added to that group if farrowing is to be completed in a short time.

Season of the year, diseases, management, and genetic makeup can influence the number of females showing estrus and conceiving at a particular time. If there is an insufficient number of females in heat during a breeding period, the farrowing group will be smaller than the capacity of the farrowing facility, increasing the fixed costs per pig produced. Although there is little flexibility in the number of producing sows in each breeding group, the number of replacement gilts is completely flexible and is determined solely by management.

The gilt pool, then, is the only part of the female breeding herd that can supply the necessary number of females to fill the farrowing facility to capacity. The gilt pool should be managed to help reduce costs and to improve the reproductive performance and scheduling success of the breeding herd. The primary purpose of the gilt pool is to provide an adequate number of acceptable replacement animals that cycle and conceive at the desired time.

You must determine in advance the number of replacement gilts that are required to complete a farrowing group. That number can be derived by examining previous records for the same season. Under normal conditions, about 15 to 25 percent of the females are culled when maximum turnover is not practiced. Past records and experience are the best indicators of the required number of replacement animals.

In determining the number of replacement gilts needed, you should expect a conception rate not higher than 60 percent. Although most producers achieve a higher rate of conception, an estimate of 60 percent is good insurance, especially during periods of poor breeding performance.

Select at least three replacement gilts for each farrowing crate that is to be filled. During periods when more breeding problems are encountered (hot weather, disease, infertile boars, etc.), the number of gilts required to insure one pregnant gilt at the desired time needs to be doubled or even trebled. The more gilts in the pool at any one time, the greater the likelihood of obtaining pregnant females on a predetermined schedule.

Many research programs have been developed to investigate various means to increase the incidence of estrus at an earlier age in replacement gilts. Basically, three management practices are valuable in reducing age at puberty.

First, moving gilts out of confinement — simply changing location and providing more space per pig — has been shown to have a beneficial influence. Second, mixing gilts with new pen-mates and rearranging social order will also stimulate some gilts to show estrus at an earlier age. These two practices have been beneficial for about 30 to 40 percent of gilts. About one-third will show estrus within four to 10 days after moving and mixing with other gilts if they are about six months old or older and have been raised in confinement.

Moving and mixing should be carried out for about three or four days before the largest number of gilts can be expected to show heat. Estrous activity should be checked for seven to 10 days following relocation, but gilts that fail to show estrus within 21 days after being relocated should be sold. Keeping gilts in the gilt pool for periods exceeding three weeks reduces reproductive performance and increases feed and labor costs dramatically for each gilt that is placed in the breeding herd. Any gilt that has not been in estrus during the first 21 days is delayed in showing estrus. If gilts are kept in the gilt pool beyond that time, selection to reduce age at first estrus will be unsuccessful.

The third practice is exposure to a mature boar. The presence of a mature male stimulates estrus at an earlier age even when gilts are still in confinement. The male's influence is due to a combination of smell, noise, and the physical contact that is a normal part of male aggressiveness in checking for estrous females. The activity of the male should be carefully observed so that a boar can be readily replaced if his enthusiasm wanes. Boars should be rotated about every two or three days, and boar exposure should be started about two weeks before gilts are to be relocated to the breeding facilities.

Feed costs increase rapidly because noncycling gilts must also be fed and maintained in order to identify the few that will cycle, reducing the use of facilities. Heavy gilts are less desirable and will be discounted at slaughter. All nonmated gilts should be dispersed from the gilt pool after three weeks of exposure.

For an easy management program, divide the gilt pool into three pens. Each week clean out one pen by moving bred gilts into their respective farrowing groups and selling the remaining gilts. At the same time, select a new group of replacement gilts according to age and move them to the gilt pool. This practice eliminates the excessive feed costs that are created by maintaining a continuous gilt pool, improves the marketability of gilts culled as nonbreeders, and increases the producer's ability to reduce age at puberty by selection.

Producers often assume that gilts will cycle if they are of the proper type. Experience and research have shown, however, that no physical characteristic is a reliable indicator of reproductive potential before puberty. Proper management, coupled with an adequate number of potential replacement gilts, provides the only solution to maintaining a breeding herd.

Summary

- The effectiveness of the use of the gilt pool determines the reproductive efficiency of the breeding herd.
- The number of pregnant replacement gilts needed can be determined from previous records. There should be three or four gilts in the gilt pool for each pregnant gilt required. It may be necessary to double the number of gilts in the gilt pool during seasons of poor breeding performance.
- Season of the year, boar exposure, relocation, and mixing with new pen-mates need to be considered in improving the efficiency of the gilt pool.
- Combine management techniques with breeding schedules to the best advantage.
- Cull all noncycling and late-maturing gilts after three weeks in the gilt pool.
- Select bred gilts that have sound production characteristics — feet and legs, temperament, underlines, etc.

Checking Estrus and Breeding

In pen-mating, the boar detects estrous females and breeds them. The major limitation of pen or pasture breeding is that the precise breeding date is usually not known, and one boar cannot serve as many sows and gilts efficiently per week as through hand mating or artificial insemination (AI).

The advantages of a hand-mating system are (1) the producer knows the exact breeding dates; (2) he can use superior sires to the best advantage; and (3) he can cull nonbreeding females or those not matching required farrowing schedules. The reproductive performance of a herd usually improves if unproductive animals are culled regularly. If you choose hand mating rather than pen or pasture mating, you need to consider the amount of labor available and "boar power." The cost of labor is high and will undoubtedly continue to increase, while the cost of the few boars that can be eliminated is relatively small.

To know specific breeding dates of gilts and sows, you must hand mate. Hand mating requires close observation in detecting estrus in order to breed estrous females at a time optimal for conception. Employ any techniques that will enable you to detect estrus.

You should learn to recognize the signs of estrus. Female swine normally assume a mating posture when in season. They will assume a rigid stance or brace themselves, and will set their ears as if listening in the rearward direction. Applying pressure to the loin region by pushing on the gilt's back or actually sitting on a gilt will often cause her to assume the mating response. If a gilt's vulva (see page 41) is obviously swollen but she does not assume the mating response when back pressure is applied, she should be driven to a boar. A gilt will stand for a boar when she may be too nervous to respond in the same way to a human.

Checking estrus in gilts is easier than checking estrus in sows. The vulva normally appears to be markedly swollen when gilts are in estrus. They seem to be nervous, often "walk" the fence if penned next to boars, and appear to be looking for a male. Because gilts seldom ride one another, riding activity is not an effective means of checking estrus in pens containing only gilts. (Sows occasionally attempt to ride one another, but again it is more often the exception than the rule.) Sows will show a greater interest than gilts in the boar. All females to be bred, regardless of age, should be housed in pens adjacent to boars. This practice increases the effectiveness of checking estrus because of the behavior of the estrous females, and the presence of the boar stimulates the estrous activity of the female. A vasectomized boar can be used, especially in the gilt pool, to help check estrus.

If only a small percentage of gilts respond to back pressure, then the number of females in the gilt pool should be considerably increased. The females that respond normally will be much easier to settle than those that respond only to a boar or appear to stand but must be restrained for breeding. Using a breeding crate will not yield a greater conception rate.

If a gilt is detected in estrus and then fails to stand for a boar 12 hours later, her chances of conceiving will be much lower. Breeding females that show irregular heat periods (too short or too long) or extreme nervousness, should be culled.

Sows normally stay in heat from 40 to 60 hours, while gilts will show estrus for 24 to 28 hours. These time periods can be dramatically shorter during warm seasons, and estrous checking should be adjusted accordingly. Check estrus twice daily when heaviest breeding activity is observed. Record individual breeding dates as aids in pinpointing the onset of estrus.

Since the female normally ovulates about 24 hours before going out of estrus or heat, and the length of the estrous period is not known until after she is to be bred, it is difficult to determine the optimal breeding time during estrus. Highest conception rates are obtained when the female is bred about 12 hours before ovulation.

The best and most reliable system for breeding gilts is to breed the female 12 hours after she is first detected in estrus, and then repeatedly every 12 hours as long as she remains receptive to the boar. This system allows most gilts to be bred at least twice during any estrous period. If a gilt does not stand to be mated without restraint, or if she remains in estrus longer than 60 hours (two and one-half days), she probably will not conceive and should be culled.

Sows should be bred accordingly to this same time schedule during periods of hot weather. During all other seasons, however, sows do not need to be bred until 24 hours after first detected in estrus, and then every 24 hours until they are no longer receptive to the male.

In warm seasons, when estrous periods are normally shorter than 36 hours, sows and, especially, gilts should be bred when they are first detected in estrus. This practice ensures that females with periods of short duration can be bred at least twice during a heat period. Breeding problems are increased and conception rates lowered when females that do not appear to be normal are bred forcibly. Depending upon luck does not improve the success of a breeding program.

Summary

- Inability to breed all gilts selected for replacement females does not represent failure. It simply means that the number of potential breeding animals should be increased.
- Check heat regularly every 12 hours, especially in the gilt pool during hot weather.
- Keep records to identify the optimal breeding time.
- Manage sows and gilts in separate pens.
- A vasectomized boar can be used to check estrus and stimulate gilts.
- Arrange breeding pens to handle animals efficiently and maximize boar exposure.
- Maintain enough "boar power" through numbers or artificial insemination (AI) to serve all females at the proper time.

Managing Boars

Boars have greater influence than sows on the average size of litters because each boar sires many more pigs than are farrowed by any one sow or gilt to which the boar has been mated. In addition, each female received one-half of her genetic makeup from her sire.

"Boar Power"

"Boar power" is a critical feature of a breeding system in which a predetermined number of females are to be bred weekly. Breeding performance and libido should not be taken for granted, as many producers have discovered, especially during the summer months. Boars are temperamental and individualistic. Some boars possess all of the desirable traits, and are aggressive and fertile; others are sterile or possess no sex drive. Although boars that lack a sex drive are self-eliminating, they cause additional problems because the other boars must be used more frequently to compensate for them.

Overusing boars, especially young boars, can be detrimental to maximum fertilizing capacity. The number of boars required in any breeding system should be based upon the number of females to be bred during any five-day period. An active, mature boar should not be expected to breed more than five females per week. Young boars should be mated to no more than two or three females per week. Because all females should be bred at least twice, mature boars should be used twice daily (10 matings weekly), and young boars no more than once daily (five or six matings weekly). Certain boars may be able to breed more than five females per week, but others may not breed when expected. As a result, some boars can be overworked. This situation can be prevented if adequate "boar power" is available at all times.

Breeding Systems

Selecting the most desirable breeding system depends largely upon your management program and physical facilities. For this reason, detailed recommendations cannot be made here. In pen breeding, it is not usually possible to identify conception dates or the breeding performance of a particular boar. When hand mating (controlled mating) or semen collection and artificial insemination (AI) are used, greater knowledge and control of the male is available, and records can be easily maintained. Breeding records can be more valuable as a measure of the boar's performance than the female's.

Whether you use hand mating or pen mating, you should mate each female to two males to achieve maximum conception rate and litter size. The possibility of breeding a sow exclusively to one subfertile boar is minimized by this practice. Using a double-siring mating system will usually improve the conception rate by 15 percent and litter size by 10 to 15 percent.

Care and Handling of Boars

The nutrition of boars has not received adequate attention from researchers. Most of the available information is based upon recommendations made for other classes of swine. Growing and mature boars seem to have a greater need for protein, calcium, phosphorus, most vitamins, and trace minerals than finishing hogs, but precise guidelines are not available. Mature boars should not be underfed or overfed. Hand feed once daily an amount sufficient for maintaining a strong, thrifty condition. Boars should be fed two to three hours before they are expected to breed.

Controlling temperature stress is a vital part of proper boar management. High temperatures can cause sterility because the production of sperm (spermatogenesis) occurs normally only at a temperature that is 4 to 7° F. (2 to 4° C.) below that of the body. The pampiniform plexus and scrotum (see pages 38-39) help maintain the desired temperature, but this mechanism is much less effective in boars than in other domestic animals that possess a fully suspended scrotum.

Swine also cannot dispose of body heat as easily as other mammals. As a result, boars are much less resistant to heat stress than males of other species, and must be given the opportunity to cool themselves to prevent heat-induced sterility. Shade may not provide adequate cooling, especially in climates where the relative humidity remains fairly high. Artificial cooling by air conditioning, fogging, or simply providing a cool mudhole in which to wallow will help reduce heat stress.

Breathing activity (panting) is the best measure of a boar's comfort. If boars are forced to pant for long periods each day to maintain their optimum body temperature, their feed consumption will be reduced, their libido will be depressed, and their fertility will be decreased and possibly destroyed. Sterility because of heat stress may last as long as eight weeks. Even if a female conceives after being mated to a boar that has suffered heat stress, the embryonic death rate will be high and litter size will be greatly reduced.

Exposure to extreme cold, especially wind, can cause the same problems if the scrotum becomes frostbitten. Localized inflammation because of frostbite will increase testicular temperature and impair the spermatogenic process. This problem can be compounded if an infection develops. If the testicle itself is frozen, sterility will be permanent. For this reason, boars require protection against undue exposure to cold.

Boar pens should be located where they will provide maximum exposure to the females to be bred. The presence of females helps stimulate the boars and keeps them interested in their work. Isolating males, especially young boars, provides no stimulus and simply increases the time and effort required for breeding because the animals must be moved continually. Locating breeding animals within the same facility helps improve exposure between sexes and simplifies handling during breeding.

Some producers believe that exercise helps prevent lameness and improves hardiness and stamina in boars, but little controlled research has been conducted on the subject. Preventing injury should be the primary consideration. Because of the rather precarious mating position, slippery floors in the breeding area can cause injury or distract the boar's attention, and can quickly discourage even the most aggressive boar. A large piece of carpet, expanded metal, cleated flooring, or concrete reinforcing wire placed on floors or slats will minimize slipping. Many confinement producers use a sand pit for breeding, but more space is required for this special feature. In the winter, ice should be removed from the breeding area, or the surface should be sanded or salted to improve traction.

Properly handling of breeding boars is crucial to behavior and performance. Males should not be abused or teased. They should be handled gently but firmly. They should never be rushed. Each breeding experience should be carried out in an environment that is conducive to improving mating performance rather than reducing it. For this reason, the aggressive behavior exhibited in young males (ranting) should be used to enhance female response to the boar. Each male should be handled in the best way to reinforce his mating performance. Common sense is the most valuable tool in handling boars successfully.

Because boars normally breed several females during each breeding season, they can be exposed to many diseases and become carriers of several reproductive diseases. Great care should be taken to insure proper health management of the breeding herd through a vigorous vaccination program, followed by constant surveillance of both sows and boars. Uterine infections, a persistent cause of nonconception in sows, should be treated to prevent contamination of more females. Consultations with a veterinarian and careful management will help solve many of the health problems that impair reproductive performance.

Summary

- Boars influence conception rate and litter size, and contribute one-half of the genetic makeup of their daughters.
- Boars lacking fertility or sex drive should be culled as soon as possible.
- For optimal breeding performance, mature boars should not be used for natural service more than twice daily; young boars should be used less often.
- The breeding system used should produce the best results in reproductive performance for the particular physical facilities and management program.

- Boars should be provided the best environment possible to enhance their breeding performance.
- Thermal stress should be prevented.
- Boars should be exposed to females as much as possible to stimulate male mating behavior.
- Slippery floors should be avoided in the breeding area.
- Breeding records should be maintained to determine the reproductive performance of boars.

Identifying Infertile Boars

Swine producers must deal almost continually with disease outbreaks, maintaining broken or old equipment, changing swine diets, etc. As a result, they often do not have enough time to select outstanding breeding stock or incorporate new management techniques. The greatest number of problems occurs in the breeding herd, where the influence on production efficiency is especially detrimental.

It is very disappointing for a producer to purchase an "outstanding" young boar and then discover that the boar is either sterile or an ineffective breeder. It is even more disappointing to purchase a boar that is fertile but not fertile enough to sire litters of average size.

There is a difference in the degree to which a sow can be bred. Research during the past decade has shown that boars may differ greatly in fertilizing capacity. The litters from the boar that breeds regularly and efficiently but has a low conception rate will probably be smaller than litters from boars with higher conception rates. The boar is not readily identified with his offspring at farrowing unless detailed breeding records are kept. For this reason, his actual fertilizing capacity will go undetected, and the sow rather than the boar is usually blamed for the small litters.

If a sow is bred to two boars at the same time, the most fertile boar will sire the most pigs. Skin color or ear shape can be used as a **genetic marker** to compare the fertility of two boars. White skin color is dominant over red or black. If a red gilt is bred to a white boar and a black boar within a short time, the color ratio of the offspring will reveal which sire was most fertile. A black boar and a red boar can be competitively mated to a red sow. The pigs will be the same color as their sire if the black boar is purebred. Because white is dominant to other colors in swine, the best female for determining competitive fertility is the red sow. The test will be inconclusive for crossbred boars unless they are red because a boar of any color other than red can carry the genes for red, black, or white skin color.

Ear shape can also be used as a genetic marker when all breeding animals are white or crossbred with respect to color. Pigs with large, droopy ears inherit this trait from one or both parents. Boars that have erect, small ears can be compared through their offspring with boars that have large, droopy ears. For best results, the females should have ears as much like one boar or the other as possible. The ratio of pigs sired by each boar is directly related to the relative fertility of the two boars used in the comparison.

Why spend time to test boars? If a boar settles a high percentage of sows, the litter size is usually adequate. Studies at the University of Illinois and in Europe indicate, however, that litter size can be significantly influenced by the sire, and that fertility differences exist even between boars from the same litter. That may be reason enough for testing, but there is an even better reason. If a boar is not tested competitively with a good boar as soon as he becomes an effective breeder, he could remain unidentified throughout his breeding career. All new boars and many older boars should be tested as soon as possible, especially during periods when breeding performance is normally low. Culling out boars that are subfertile will improve conception rates, especially during periods when some boars may be overworked.

Introducing New Breeding Stock

When purchasing animals for the breeding herd, your primary concern should be protecting the original herd from the introduction of new disease organisms or different strains of existing disease organisms. The recently purchased animals should also be protected from their new environment until they have had time to acclimate to their surroundings and develop sufficient immunity through gradual exposure. Breeding animals should *never* be purchased from herds that are known to be reservoirs of certain serious communicable diseases.

To reduce the potential of introducing a disease like Pseudorabies Virus (PRV), you must follow effective quarantine procedures. Make certain that the transporting vehicle is as clean as possible. It should be washed and, preferably, steam-cleaned before the new animals are loaded. It should be bedded with clean, dry straw during cold weather, and with moist sand or sawdust during warm weather.

The facilities in which new animals will be quarantined should provide the same comforts as the transporting vehicle. These facilities should not be located adjacent to pens or buildings being used by other swine. The quarantine buildings and pens should be constructed so that they can be easily cleaned and rebedded for each group of new arrivals. Water should be readily accessible.

Observe the new animals for signs of sickness at the end of the work day. Do not return to the original herd after caring for the new animals. For effective isolation, you should change clothes, especially boots, and even use rubber gloves when feeding and handling new animals. *Do not wear* these clothes when you are with the original herd, or keep them with other clothes worn when you are with the original herd.

New animals should be tested for PRV prior to purchase, and then should be retested after a 30-day quarantine. They should also be tested for Brucellosis and Leptospirosis at the same time. You should follow the same vaccination program for new animals that you follow for other animals as soon after purchase as possible. New animals should not be routinely vaccinated for PRV except upon recommendation of a veterinarian.

Following the first 30-day quarantine period and retesting for PRV, the new animals can be gradually exposed to other swine. Market-weight animals can be housed with new animals for a short time before being sold; or manure from the farrowing barn or gestation facility can be taken to the quarantine area to initiate exposure of new animals. This exposure period should be at least two weeks.

A minimum of six weeks is required to introduce new animals properly into the breeding herd. This time period must be taken into account long before new animals are actually needed for replacement or expansion of the breeding herd.

During quarantine, you should make every effort to prevent minor sickness that may cause a fever in boars because they could be temporarily sterilized as a result. Observe the boars daily for signs of heat stress (panting and excessive water intake), lameness, swelling of joints, coughing and other respiratory problems, and general unthriftiness. Make certain that they have an ample supply of clean water and that they drink, especially during the warm months.

Although semen from new boars can be checked once a month for live, motile sperm, this semen should not be used for artificial insemination (AI) during the first 30-day quarantine period. Following the 30-day test for PRV, new boars can be used for semen production and AI without any problems. The sooner the boars are worked, the better.

Breeding animals that have been taken to livestock shows should be considered as new animals when they are brought home because of their exposure. They should be quarantined as strictly as animals purchased from a different herd.

There are three alternative methods of acquiring new genetic stock with little or no risk of disease. These include embryo transfer, hysterectomy, and AI. In embryo transfer and hysterectomy, genetic material from both parents is purchased; in AI, only the sire is represented genetically. The question you must answer for yourself is whether your best sows that will be inseminated are equal to the sows that would be donating ova or pigs through the other methods. Only herds of certified health status are acceptable sources of embryo, pigs, or semen.

Compare the monetary advantages and disadvantages of embryo transfer, hysterectomy, and AI before making a decision. The likelihood of disease transmission is essentially the same in all three cases. Proper surgical procedures are required for embryo transfer or hysterectomy. Proper isolation between semen collection and insemination is necessary to reduce disease transmission in transporting fresh semen.

The cost of embryo transfer should reflect the value of the genetic material and the cost of the surgery. Veterinarians usually charge $200 to $300 per donor sow for embryo recovery, and $75 per recipient for sows impregnated with embryos. Since hormones for superovulation are normally administered to increase egg production by the donor sow, more than one litter may be produced. If hormones are not used for superovulation, only one litter can be produced per transfer. Inseminating four to six progeny-tested sows with fresh, diluted semen yields three to four litters per collection. Assuming that females are of similar quality, the production of outstanding offspring would be three or four times greater using fresh semen, and the cost per boar would be significantly lower with AI.

For embryo transfer to be successful, special facilities are necessary, and trained personnel must be involved in the recovery and transplantation of embryos. The collection of semen and the insemination of sows require a minimum of facilities and special equipment. Nearly anyone can do the job, as long as proper procedures are followed. The percentage of success on embryo transfer is approximately 70 percent, about the same as for AI.

When a hysterectomy is performed, the uterus is taken from the sow very near her term, and the pigs are collected in a sterile environment. In this process, the sow is usually sacrificed and a foster mother rears the piglets. The foster mother must farrow very close to the time that the pigs are recovered by hysterectomy so that colostrum (see page 34) is available. New genetic stock for Specific Pathogen-Free (SPF) herds is normally obtained by this procedure. Because the female is sacrificed, the cost of this method per animal obtained is probably somewhat higher.

Embryo transfer, hysterectomy, and AI are equally advantageous to both purebred and commercial producers. Because there will always be a market for young boars, these three methods of introducing new breeding stock will give the better purebred breeders a greater competitive edge than they would otherwise have.

Artificial Insemination (AI)

Collecting semen from a boar and inseminating a sow to induce pregnancy has been successfully practiced for many years. The technology has been developed to such a point that conception rate and litter size are no different between sows and gilts bred by natural service and those bred by AI.

The use of superior sires is greatly extended through semen dilution and AI. As many as four to six sows can be bred per ejaculate; however, the semen can often be extended through dilution to increase mating potential three times. AI also provides greater knowledge of deformities in the reproductive tracts of females, eliminating potential problem breeders. Young gilts are not subject to injury even though they can be mated artificially to very large boars. The boar herd can be used more effectively without fear of overworking a few superior boars during the hot seasons. Boar numbers can be reduced significantly, and more superior boars can be purchased for the same cost as a larger number of inferior boars. Disease problems can be more easily controlled by eliminating carrier animals from the mating process, and anatomical defects in the reproductive tracts of boars can be easily detected during semen collection.

AI also has several significant disadvantages in swine production. You must select sires carefully because genetic defects can be compounded by at least four times and possibly a good deal more. The genetic history and performance of a prospective herd sire must be completely investigated for recessive genetic defects that may appear in his offspring.

For AI to be successful, estrous activity must be checked regularly to determine the optimal insemination time. The optimal time for fertilization of the egg or ovum is within six to eight hours after ovulation. Sperm cells need to be deposited before ovulation so that they have sufficient time to travel to the site of fertilization — the oviduct (see page 37). Sperm cells retain maximum fertilizing capacity up to 14 or 16 hours after deposition in the female tract. For these reasons, insemination time within the estrous period is critical to the success of an AI program.

Management efficiency must be improved to realize fully the benefits of AI. A great deal of time must be spent in maintaining the cleanliness of all insemination equipment to prevent the spread of disease. If strict hygienic practices are not followed, the threat of widespread disease contamination is a real possibility. On a limited basis, however, the advantages of AI clearly outweigh the disadvantages.

Training the Boar

Before you can collect semen successfully, you must accustom the boar to your presence during mating. Electroejaculation of boars is not feasible. For best results, a young boar should be encouraged to breed several females with human assistance, and then attempts should be made to collect semen while the boar is mounted on a sow. Following this practice, a suitable dummy can be placed in the breeding pen. The dummy should be at least six feet long, well padded, sturdy, and stable. Old carpet or burlap make excellent covering materials.

The boar may need several exposures to the dummy before he understands its purpose. To encourage the boar, scent the dummy with boar urine, semen, or urine from an estrous female. The dummy should not be cleaned. Once collection using the dummy is successful, a sow should not be used unless the boar becomes uninterested. Patience is the key to training and handling boars successfully.

Collecting Semen

The boar needs to be relatively clean — at least his belly should be free of dirt, mud, or feces. The hair should be trimmed around the sheath area. Once the boar has mounted the dummy, the penis can be guided to one side during the thrusting motions. The penis should be held lightly until near full extension; then it should be gripped firmly at the glans penis or terminal end. Once pressure is applied, the boar will usually stop thrusting and a pumping rhythm will be initiated. Discard the first clear seminal fluid (see **dilute fraction,** page 34). Begin collecting the semen when it takes on a milky appearance — the **sperm-rich fraction** (see page 40). Use a warm container to prevent cold shock. Styrofoam cups seem to be best for this purpose. They are disposable and relatively inexpensive.

The boar should be allowed sufficient time to complete ejaculation. For a good collection, prepare to "hold" your position for up to five minutes. Gel does not need to be added to the semen, but should be smeared on the dummy to maintain the proper aroma. The semen should be strained through two layers of cheesecloth before dilution to remove the **gel fraction** (see page 35).

Handling and Diluting Semen

Cleanliness is the key to semen collection and handling. Dirt impairs semen fertility, and both soap residue and pure water are spermicidal. Collection and handling equipment must be close to body temperature to prevent the sperm from undergoing cold shock.

Several semen extenders are available (see chart on page 24). Skim milk is the least expensive because it does not require the addition of chemicals to adjust ionic concentration. Research trials have shown that no extender is superior to any other if diluted semen is used within four hours after collection. Warm the extender to the temperature of semen, or (if semen is at room temperature) allow the extender to adjust to room temperature before mixing.

The best mixing ratio is one part semen to one or two parts extender. This quantity can be used to breed from four to six females, depending upon sperm concentration. If semen is less than "milky" in appearance, use a lower dilution rate (perhaps one to one).

If a microscope and a sperm-counting device (hemocytometer) are available, dilute according to the live, motile sperm concentration

Semen Extenders

Skim milk (pure only)

1. Heat in a double boiler to 190° to 195° F. (88° to 91° C.) for 10 minutes. *Do not boil.*
2. After cooling to room temperature, break one whole egg into the milk (2 to 4 cups) and mix well (slowly, not beating to a froth) for 3 minutes.
3. Warm or cool the mixture to within 2 degrees of the temperature of the semen.
4. Add the extender to the semen, slowly pouring it down the side of the container.

Powdered skim milk

1. Mix powdered skim milk with warm deionized water (95° to 100° F. or 35° to 38° C.). Repasteurization is not necessary.
2. Follow steps 2, 3, and 4 above.

Beltsville Boar Semen Extender (BL-1)

(Developed at Agricultural Research Station, Beltsville, Maryland)

Glucose	29 grams per quart
Sodium citrate	10 grams per quart
Sodium bicarbonate	2 grams per quart
Potassium chloride	3/10 gram per quart
Streptomycin sulfate	1 gram per quart
Penicillin G, crystalline	1 million IU

All of the chemical components of the BL-1 extender can be purchased or ordered from your local pharmacy. The pharmacy probably also stocks dietary scales that vary to the nearest gram. The extender components should be mixed for a 10-quart batch. Add about 42½ grams of the mixture to one quart of deionized distilled water, *not* tap water. This extender can be stored in dry form for long periods of time, and then simply added to warm, distilled water when needed. It should not be stored as ice cubes in a frost-free freezer.

Egg yolk semen extender

Egg yolk	950 cc
Distilled water	2,217 cc
Glucose	95 grams
Sodium bicarbonate	4¾ grams
Streptomycin	4¾ grams
Penicillin G, crystalline	3,176,000 IU

(about 50 to 100 million sperm per cc). A diluted semen volume of 50 to 75 cc containing at least three billion live sperm cells is the recommended amount per insemination for each female.

If a microscope is not available, dilute sperm no more than twofold. **Unless you are maintaining a purebred herd, always mix semen from at least two and preferably three boars for dilution and insemination.** Inseminate as often as natural breeding is recommended. All extenders should be prepared or mixed fresh daily for best results. Do not store extended or fresh semen for more than eight to 10 hours.

Collecting, diluting, and inseminating equipment must be kept clean and warm and as near the temperature of semen as possible. Drafty sheds are not suitable semen laboratories. An old, nonfunctional refrigerator makes an excellent storage and warming facility if a heat tape, connected to a thermostat, is attached under the middle rack. Extender, distilled water, and all other equipment can be stored in the refrigerator to maintain a uniform temperature.

Equipment

Again, cleanliness is of paramount importance. If disposable inseminating equipment provides the easiest means to maintain cleanliness, use disposable pipettes. If all instruments, including rubber inseminating spirettes, are sterilized by immersing in boiling water for 20 minutes, they probably provide the best means for insemination.

Two semen applicators (the squeeze bottle and the 60-cc disposable syringe) have been used with equal success and efficiency. Use the method that works best for you, but be sure that you have the proper adapter if needed.

Inseminating

Be certain of the correct time to inseminate each female. Check heat and maintain records accordingly. Do not attempt to force-breed any female. Apply a light coat of lubricant KY jelly or vaseline to the sow's vulva. Insert the pipette in the vagina at an upward 45-degree angle, and twist with a counterclockwise motion in order to bypass the urethral orifice (see page 41).

Enter the cervix (see page 33) if it is open. You can "feel" a couple of ridges if you are in the proper location. After the rubber spirette is worked into the cervix, it will be held there by cervical constriction. Try to imitate the thrusting motion of the boar. Gentle semen expulsion should follow. If backflow occurs, the spirette or pipette is not placed properly. Do not force the semen too rapidly.

Summary

- The success of AI depends upon the accuracy of checking estrus.
- AI allows you to identify and cull any animal exhibiting a physical defect or abnormal mating behavior.
- Equipment *must* be kept clean. Use disposable equipment whenever possible to reduce maintenance time.
- Prevent temperature shock of the semen during handling and insemination.

Causes of Reproductive Failure

The reproductive process consists of many phases. All of these phases contribute to success or failure in producing live offspring. The number of unfertilized eggs, embryos, fetuses, and baby pigs that are lost is equal to the average number of pigs weaned in each litter. Although this loss is not abnormal, it is substantial enough to justify any efforts to improve the management program.

There are five major causes of reproductive failure: (1) hormonal imbalances; (2) the mating behavior of both males and females; (3) diseases and minor infections; (4) structural defects; and (5) the producer's inefficiency in checking heat and handling the breeding herd.

Small litters are usually caused by the reproductive failure of one parent or an improper breeding system or management program. Conception failure is probably a more severe result of the same problems that cause small litters. Examining the performance records of both boars and sows will help you to adjust your management program to improve reproductive performance. Because many of the elements involved in the reproductive process are interrelated, one problem may give rise to others. In many cases, however, the primary cause of reproductive failure can be identified and corrected.

Hormonal Imbalances

When a hormonal imbalance is the cause of reproductive failure, the estrous cycle of the female is usually abnormal. A gilt or sow may remain in estrus for an extended period of time (usually as a result of a cystic ovary), or she may be in estrus for a very short time, perhaps less than 12 hours. In either case, because of aging or immaturity of the ova or improper development of the uterus (any of which may prevent conception and normal embryonic development), these gilts or sows are much less fertile than females that have normal periods of estrus. Irregularity of the estrous cycle (extremes of less than 18 days or greater than 22 days) usually results in reduced fertility for the same reasons.

Failure to reach puberty or to show first estrus at a reasonable age (seven to eight months) appears to be a mild manifestation of a hormonal imbalance. Although various environmental conditions have been identified as causing hormonal problems, not all animals are influenced to the same degree by similar conditions. Animals whose hormonal systems are upset or irregular are probably susceptible to other negative environmental stimuli, and should be eliminated from the breeding herd. It is not reasonable to expect all females to conceive or all males to breed effectively simply because they have been selected for the breeding herd. Those animals that do perform normally will be most fertile, and have the greatest potential for conceiving at a reasonable time.

Not all hormonal imbalances occur because of failure within the animals themselves. With the development of new harvesting and drying equipment, feed grains (corn in particular) are sometimes stored with moisture levels that promote mold growth. These molds can produce a class of compounds known as **aflatoxins** (see page 33) that can be quite toxic to swine.

Feeds containing the aflatoxins often possess estrogenic compounds that can force a female to show such symptoms of estrus as vulvular swelling, assumption of a mating posture, and acceptance of a boar for extended periods of time, even continually in some cases. Excessive development of the mammary glands in immature gilts and occasional inversion of the anus (see **rectal prolapse**, page 39) have also been reported as common symptoms caused by estrogenic substances in moldy corn. Both anestrus (see page 33) and extended periods of estrus, followed by conception failure, have occurred in sows after weaning; embryonic reabsorption or abortion has resulted when the diet of pregnant sows was known to contain a relatively high level of aflatoxins. Because estrus is not accompanied by ovulation, the female cannot become pregnant.

Prolonged exposure to these compounds may be lethal or may permanently alter the reproductive process, even after the diet is changed. For this reason, feeds containing aflatoxins should *never* be fed to the breeding herd or candidates for the breeding herd. In most cases where aflatoxins are a problem, a large percentage of the population (often 80 percent or more) has been disturbed hormonally. Animals that are afflicted with strictly internal hormonal problems seldom represent more than 10 percent of the breeding herd.

Research at Iowa State University, the University of Illinois, and at several European institutions indicates the existence of a condition known as the **Porcine Stress Syndrome** (see page 38). This condition or **stress susceptibility** (see page 40), which manifests itself in a hyperactive and hypersensitive response, tremors, and sudden death, is related to inherited infertility caused by hormonal imbalances. Stress susceptibility was introduced genetically into many swine herds when extremes in leanness and heavy muscling were the primary objectives of selection programs. Using boars with these characteristics leads to a high degree of infertility — that is, gilts fail to come into estrus. Infertility or subfertility has also been reported in boars that are known to be stress susceptible.

Reproductive Behavior

Hormonal problems can result in deviations from normal reproductive behavioral patterns. Females may be extremely aggressive or timid, and the same behavior may occur in boars. Animals that display behavioral extremes, whether from hormonal imbalances or undesirable social interactions, cannot be considered sound in a reproductive sense. Some animals with normal hormonal balance may be frightened by an aggressive mate to such a degree that proper mating behavior is impaired.

These situations should be avoided, especially for young, inexperienced breeding animals. Young boars should learn their sexual function with docile gilts or sows. Virgin gilts should be bred to small, gentle boars. Other distractions, especially rough treatment by humans, should not be allowed to interfere with any animal's mating instincts. Physical abuse *will not* improve reproductive efficiency.

Sows that eat or kill their pigs may be adversely influenced by the confinement of the farrowing crate or may be too nervous to be efficient producers. Handling techniques or extreme excitability resulting from genetic factors may be the cause of behavior problems in sows.

Many producers raise young boars in groups to determine performance and growth rate. During the period associated with puberty, young males can become imprinted with an improper sexual preference unless exposed to females during that critical time. Even though its sex drive and hormonal balance are probably normal, the young boar may be managed in an environment that prevents proper training. Showing mating preference for a male even when in the presence of an estrous female is the result of mismanagement during a critical period of development. The situation is often difficult to correct once mating behavior is established.

Diseases and Minor Infections

The primary effects of disease organisms on the reproductive process are conception failure, abortion, stillbirth in the female, and sterility (absence of sperm) in the male. Most disease organisms do not have a direct influence on the hormonal status of the host animal. The greatest area of invasion and infection is in the reproduction tract, where diseases cause abortion in pregnant females by disrupting the placenta (see page 38) or by killing the embryo or fetus. The major diseases of concern to swine producers are Leptospirosis, Pseudorabies, and SMEDI (stillborn pigs, mummified pig, embryonic death, and infertility). (See pages 37, 39, and 40.) Routine vaccination programs, where permissible, and veterinarian diagnosis should be used in all cases where specific disease organisms are present.

Inflammation of the uterus, known as **metritis** (see page 37) is usually caused by unclean farrowing quarters and lower disease resistance in the sow. If the condition persists for three or four days, preventive steps should be taken. Several types of antibacterial flushing solutions are available to clear up the infection. Only proven products should be used, and dosage or application levels should be followed. Professional assistance may be required.

Boars are also subject to disease organisms, and can transmit venereal diseases to a large number of females. Any disease that causes elevation of body temperature may cause temporary sterility in the boar, but few disease organisms that result in blockage of the epididymis (see page 34) or other portions of the male reproductive tract have been detected in swine.

Structural Defects

Structural defects in the reproductive tract are caused by hormonal imbalances and injury or are of genetic origin. Once the cause of a structural defect is determined, the animal should be eliminated if the problem is genetic or hormonal in origin. If the animal has been injured, its value depends upon its ability to continue as a breeding animal. If the injury impairs the animal's ability to reproduce, then it should be sold. All potential breeding animals should be examined for structural defects to eliminate problems before they occur.

Timing Management Decisions

You can have a significant influence on the timing of various events in swine production, especially if you develop a breeding system other than pen mating. Union of egg and sperm requires critical timing for maximum conception rate and embryo survival. Failure to detect estrus in gilts and sows will reduce conception rate and litter size because the optimal time for mating will not be known.

Various disease organisms and minor infections in females should be controlled early enough to allow sufficient recovery time before conception. Too many producers fail to introduce proper preventive procedures before reproductive failure is apparent. Many breeding problems can be solved before they seriously influence conception rate or litter size. Breeding stock should be selected with extreme care because hormonal problems and physical defects are largely inherited.

By becoming familiar with the causes of various types of reproductive failure, you can often alter management practices to provide a better environment for breeding stock. Professional consultation should be obtained whenever it is needed.

The following list may be of value in identifying the causes of problems that might occur in various phases of the reproductive process. Warning signs can be good indicators of managerial or environmental problems.

If gilts are not cycling:

- There may be genetic inhibition. Delayed puberty may result.
- The gilts may be responding to high-temperature stress. It may be necessary to cool the breeding area.
- There may be environmental problems such as overcrowding.
- The feed sources should be examined for aflatoxins and mycotoxins. These toxins may indicate the presence of estrogenic compounds.
- The gilts should be examined at slaughter plant.

If sows are not cycling:

- The quantity of feed may need to be increased if the sows (especially first-litter sows) are not on full feed.

• There may be a uterine infection (indicated by vaginal discharge any time later than two days after farrowing). Flushing is recommended.

• The sows may be responding to high-temperature stress. It may be necessary to cool the farrowing house and breeding area.

• Examine the tracts of sows at slaughter for uterine infections, physical defects, and ovarian activity, as indicated by the presence of corpora lutea. (See **Corpus luteum,** page 34.)

• Aflatoxins may be the cause.

If gilts and sows are recycling but not settling on schedule (returning to estrus in 21 days):

• Check the fertility and breeding behavior of the boars. These are probably the best indicators of boar problems.

• Check boars for heat stress that may have occurred during the preceding five to seven weeks if boars were once fertile.

• Examine gilts and sows for mild uterine infection and sows, especially, for unusual vaginal discharge.

• Aflatoxins may be the cause.

If gilts and sows return to estrus sooner than 21 days:

• There may be an endocrine problem or hormonal imbalance that either prevented conception of a nonfertile egg or embryonic loss caused by improper conditioning or preparation of the reproductive tract.

• Estrogenic compounds associated with aflatoxin-contaminated feed may have caused endocrine problems and a short nonovulating cycle.

If gilts and sows return to estrus later than the first 21 days post-breeding:

• There is usually a disease problem. Check with a veterinarian and initiate a vaccination program, if warranted, especially for Leptospirosis. Other diseases may also be present.

• Heat stress during the first two weeks post-breeding may have induced embryonic loss sometime later.

• Moldy corn may contain aflatoxins and estrogen that can cause reproductive problems. Abortion or reabsorption of the embryo and fetus may occur later in the term, especially if the condition is widespread, and if breeding animals are being fed corn that may not have been properly dried.

If boars fail to breed and seem to lack libido:

- The problem may be genetic. The condition probably *will not improve.*
- The temperature may be too high. Boars suffering from mild or severe heat stress are inclined to breed less frequently, and the breeding area should be cooled.
- Boars may have been injured during breeding attempts.
- Lameness or age may be causing stiffness.
- Boars may be too fat.
- Boars are not being fed at the correct time, and may be hungry when they are expected to breed.
- Improper handling. Boars may be overworked or afraid.

If there is conception failure because of the boar:

- The boar may be suffering from heat stress.
- The boar's breeding behavior may be improper. It is possible, for example, that the boar does not complete copulation.
- The boar may be diseased or a carrier.
- It may be the result of general infertility, probably of genetic origin.
- The boar may have a physical defect in the reproductive tract.

If litters are small, both sexes should be examined for:

- Genetic problems.
- Diseases.
- Heat stress.
- Fertility of particular boars or sows.

If only a small number of live pigs are born at term, and there are many mummified or stillborn pigs of normal size:

- Diseases (SMEDI, PRV, Parvovirus, Leptospirosis, etc.) may be the cause.
- There may be too many pigs in the uterus (20 or more can result in termination of pregnancy before term).
- The time required for the farrowing process is too long.
- The problem may be genetic (perhaps low postnatal survival caused by inbreeding or lack of hybrid vigor).
- The problem may be environmental. Seasonal heat may cause the sow to become exhausted.

GLOSSARY

Aflatoxins. Toxins produced by strains of molds that flourish on corn, soybeans, and other cereal grains in the field or during storage when moisture content and temperatures are high. Estrogenic substances are also often produced by these molds. Moldy feeds should always be suspected of containing aflatoxins.

Ampula. That portion of the male reproductive tract where the vas deferens joins the base of the penis. See illustration, page 43.

Anestrus. The period when the female is no longer experiencing the cyclic reoccurrence of estrus every 21 days. Although anestrus is usually caused by pregnancy and the resulting lactation, it may also be caused by an inadequate diet or environmental stress, such as prolonged exposure to heat or cold.

Artificial Insemination (AI). Collecting semen from a boar and depositing (inseminating) it into the cervix of a sow or gilt to achieve pregnancy.

Atrophic rhinitis. A serious disease of the upper respiratory tract. Coughing, sneezing, bleeding from the snout, and severe distortion of the snout are major symptoms. The performance of pigs infected with atrophic rhinitis is usually much lower than that of healthy pigs.

Barrow. A castrated male swine.

Boar. A male swine that has not been castrated.

"Boar Power." The ratio of boars to sows that are to be bred during a particular period of time.

Brucellosis (Undulant fever). A disease that causes abortion in pregnant females and intermittent fever in infected animals. Carrier animals frequently transmit this disease to healthy animals during copulation.

Bulbourethral gland. A gland in the reproductive tract of the boar that contributes fluid to the semen during ejaculation. See illustration, page 43.

Cervix. The muscular junction between the vagina and the uterus in the female. During the mating process, this portion of the female reproductive tract stimulates the glans penis of the male by muscular constriction, causing the male to ejaculate. The cervix is normally open when the female is in estrus, but is closed during the remainder of the estrous cycle and during pregnancy to prevent contamination of the uterus. See illustration, page 43.

Colostrum. The first milk that is produced for about 12 hours after farrowing. The colostrum contains a large amount of natural antibodies that can provide protection for the newborn pig until its own system is able to produce sufficient antibodies. Consumption of colostrum in its first feeding is vital to survival of baby pigs.

Conception. Fertilization of the egg or ovum by the sperm, resulting in an embryo. To "settle."

Corpus luteum (CL). A tissue (gland) that develops in place of the follicle after the ovum is released. This tissue produces and releases the hormone progesterone that maintains the state of pregnancy in the female. The development and function of the CL depends primarily upon the luteinizing hormone (LH).

Crossbreeding. The mating of two animals of different breeds.

Cross fostering. Transferring piglets from one sow to another to balance litter size after farrowing.

Dilute fraction. The portion of a boar's semen containing the least sperm. This clear seminal fluid is not normally used for artificial insemination (AI) because it may contain a large quantity of urine and is often highly contaminated with bacteria.

Egg. See **Ovum.**

Embryo transfer. A process through which newly fertilized eggs (embryos) are removed from one female and transferred to another for the remainder of gestation. If proper sanitation practices are followed in embryo transfer, some diseases can be controlled in introducing new breeding stock.

Epididymis. An accessory reproductive organ surrounding the testis in which sperm cells are stored during maturation. The epididymis has two lobes, one on each end of the testis, connected by a small, narrow midsection. See illustrations, pages 42-43.

Estrogen. One of the female sex steroids. Estrogen is primarily responsible for the state of estrus (heat). It is produced primarily by cells lining the follicles of the ovary, and reaches its highest level in the bloodstream just prior to estrus. Secondary sex characteristics in the female and the development and growth of the female reproductive tract depend upon estrogen.

Estrous cycle. The regular occurrence of estrus from one period to the next. A female is considered to be cycling if estrous periods occur at regular intervals.

Estrous period. The time interval in the estrous cycle during which the female is receptive to the male.

Estrus (Heat). Receptive to being bred. This physiological and psychological state is caused primarily by high circulating levels of estrogen produced by the ovarian follicles just prior to ovulation.

Farrow. Female swine giving birth. Parturition.

Farrowing interval. The period of time between consecutive farrowing dates.

Fimbria. Funnel-shaped end of the oviduct surrounding the ovary that collects and channels the ova into the oviduct during ovulation. See illustration, page 43.

Follicle. The fluid-filled, blisterlike structure on the ovary in which the egg or ovum develops and in which estrogens are produced. One follicle contains only one ovum. See illustration, page 44.

Follicle-stimulating hormone (FSH). One of the two hormones produced by the pituitary to control function of the gonad. FSH is primarily responsible for the development and growth of follicles in the female, and is partially responsible for sperm production in the testicle of the male. The secretion of FSH and LH are regulated by the gonadotropin-releasing hormone (GnRh) from the hypothalamus.

Gametocyte. The primary reproductive cells of reproduction (sperm or ovum).

Gel fraction. The portion of a boar's semen containing the major quantity of gelatinous material.

Genetic marker. A trait (coat color, ear shape, or blood type) that can be used to identify offspring of specific parents. When two boars sire pigs in the same litter, the offspring of each boar may be identified by genetic markers that measure the fertility and inherited traits of each sire.

Gestation. The phase of embryonic and fetal development that occurs in the uterus of the female between conception and farrowing. In swine the gestation period is approximately 114 days.

Gilt. An immature female swine. A female is considered a gilt until she farrows her first litter.

Gilt pool. A group of virgin females considered for replacements in the breeding herd. The gilt pool must be properly managed to maintain the breeding herd.

Glans penis. The end or terminus of the penis in the male. In the boar the glans penis has ridges that function in the same manner as threads in a screw. These ridges are held by the cervix of the female during copulation, causing the male to ejaculate. See illustration, page 43.

Gonad. The primary sex organ of the female (ovary) or the male (testis). The gonad is the source of gametocytes and sex steroids.

Gonadotropic-releasing hormone (GnRH). A hormone produced by the hypothalamus to control LH and FSH secretion from the pituitary.

Gonadotropins. Hormones produced by and released from the pituitary to control the function of the gonad. There are two gonadotropins: the follicle-stimulating hormone (FSH) and the luetinizing hormone (LH). These hormones are completely different in chemical composition from the steroids.

Hand mating. The male is allowed to mate an estrous female only under supervision and on a restricted basis. He is then prevented from further mating with the same female for 12 or 24 hours. The same boar may be mated to the same sow a second time, and other sows may be bred to that boar. The number of sows or gilts that can be serviced by one boar in hand mating is considerably greater than the number that can be bred by pen mating, and the exact breeding date is known.

Heat. See **Estrus.**

Hormones. Chemical compounds produced by glands and secreted into the bloodstream within the animal. Hormones generally control biochemical and physiological processes, as opposed to muscular control through electrochemical means by the nervous system. Hormones are chemical messengers within the body.

Hypothalamus. A section of the brain that coordinates and controls many of the hormonal systems (source of GnRH) of the body, as well as the visceral nervous responses. It is reponsible for controlling nearly all of the subconscious physiological reactions in the body.

Hysterectomy. Removal of the uterus of the female. In swine a hysterectomy is performed close to the predicted farrowing date in order to recover unborn piglets and maintain them in a germ-free environment until they are transferred to a foster mother.

Interstitial cells (Leydig cells). Cells in the testis that produce testosterone in response to LH from the pituitary. See illustration, page 42.

Leptospirosis. A common disease among animals that usually causes abortion in pregnant sows or delivery of weak or stillborn piglets at farrowing. Leptospirosis is transmitted by contaminated feed and water or during breeding.

Leydig cells. See **Interstitial cells.**

Libido. Sex drive or agressiveness exhibited by the male.

Luteal phase. That period (about two-thirds) of the estrous cycle during which the CL forms and produces progesterone.

Luteinizing hormone (LH). A gonadotropin produced by and released from the pituitary in response to GnRH from the hypothalamus. The primary functions of LH are to stimulate maturation of the follicles, ovulation, and progesterone production by the CL of the female. LH is also responsible for testosterone production in the male.

Metritis. A general infection of the uterus after farrowing that is usually more prevalent when the farrowing facility is not cleaned regularly and sows are not in good health. The symptoms include fever, listlessness, loss of appetite, and frequently a pustular discharge from the vagina.

Mycoplasmic pneumonia. A chronic, deep-seated cough and pulmonary inflammation that persists throughout the growing-finishing phase. The function of the animal's lungs may be severely impaired. Death is rare, but poor performance and reduced appetite are common effects of this disease.

Mycotoxins. Toxic substances produced by various fungi or molds on cereal grains during storage or in fields when conditions are moist and warm.

Ovary. The primary reproductive gland of the female that is the source of ova as well as the female sex steroids estrogen and progesterone. See illustrations, pages 43-44.

Oviduct (Fallopian tube). A small duct that extends from the ovary to the uterine horn and is the normal site of fertilization. See illustration, page 43.

Ovulation. Rupture of the follicle and release of the ovum from the ovary. Ovulation is believed to occur by the action of LH on follicular cells. See illustration, page 44.

Ovum (plural ova). Egg. The female gametocyte that develops in the follicle of the ovary.

Pampinoform plexus. A highly coiled system of blood vessels that transports blood to and from the testis. The testis is cooled by the scrotum dropping away to allow increased air flow over this area of the body. This feature is critical to the maintenance of fertility in most domestic mammals in which spermatogenesis is highly temperature sensitive. See illustration, page 42.

Penis. Male reproductive organ necessary for deposition of semen into the cervix of the female during natural mating. See illustration, page 43.

Pen mating. Boars are maintained in a pen with females and allowed to mate at random and without supervision.

Pituitary. A very small endocrine gland located beneath the hypothalamus. The gonadotropic hormones FSH and LH are produced by and released from the pituitary gland in response to GnRH from the hypothalamus.

Placenta. The fetal and maternal membranes that protect and nourish the unborn young of mammals. Nutrients, waste products, gases, and certain antibodies readily cross the placental barrier from mother to fetus.

Porcine stress syndrome (PSS). A condition in which certain pigs show extreme excitability, anxiety, tail and leg tremors, blanching of the skin, and high rectal temperature in response to stress. The condition is inherited, and it is at least partially related to extremes in leanness and muscularity. The survival rate and reproductive capacity of pigs with PSS are usually reduced.

Progesterone. The female sex steroid produced by CL on the ovary following ovulation. The primary functions of progesterone are to prevent ovulation during the luteal phase of the estrous cycle and during pregnancy, and to maintain the proper uterine environment during pregnancy. Progesterone is antagonistic to estrogen in most physiological and psychological responses, but the two hormones act in concert to establish the rhythmic estrous cycle.

Prostate gland. One of the three accessory sex glands in the male that contribute seminal fluid to the semen upon ejaculation. See illustration, page 43.

Pseudorabies virus (PRV). A neural infection resulting in encephalomyelitis (inflammation of the brain and spinal cord). Swine are the natural hosts and principal carriers of this disease. PRV is fatal to most laboratory animals, pets, cattle, and sheep, as well as suckling piglets. Mature swine usually do not display any symptoms except for abortion or stillborn and mummified pigs in pregnant sows. Serum neutralization tests can confirm infection by this organism through blood samples. Quarantine and vaccination programs are the only effective means of controlling PRV.

Puberty. Attainment of sexual function after adolescence. Puberty is expressed by the first estrus in gilts. The occurrence of puberty is less specific in the boar, but it is characterized by a significant increase in testicle size and successful mating.

Rectal prolapse. Inversion of the anus in pigs because of an inherited weakness in the tissues supporting the anus. This trait is normally recessive, and it must be carried by both parents in order to appear in the offspring.

Reproductive performance. The number of offspring produced per female at each farrowing. Fecundity.

Scrotum. The pouchlike enclosure that supports the testis outside of the body cavity in male mammals. The relaxation or contraction of the scrotum controls the temperature of the testis, promoting spermatogenesis. See illustrations, pages 42-43.

Secondary sex characteristics. Those physical characteristics unique to femininity or masculinity in females and males. These traits are reduced or completely absent in castrated animals. The muscular development of the neck and shoulders and the pitch of the voice are secondary sex characteristics in males. Females have more refined heads and forequarters than the males but greater pelvic development.

Semen. The fluid from accessory sex glands (seminal fluid) and sperm cells from the testes produced during ejaculation.

Seminal vesicle. One of the accessory sex glands that contribute fluid to semen. See illustration, page 43.

Seminiferous tubules. The tubelike arrangement of cells that produce sperm cells in the testis. The activity of these cells is regulated by FSH and, to a small degree, by testosterone. The proper development of sperm cells depends upon a temperature that is 4° to 7° F. (2° to 4° C.) below body temperature. See illustration, page 42.

Sheath. The external opening of the urinary and reproductive tract of the male. See illustration, page 43.

Sigmoid flexure. The S-shaped curve at the base of the penis that accounts for its extension. See illustration, page 43.

SMEDI. A collective term describing stillborn pigs, mummified pigs, embryonic death, and infertility. These problems are caused by a wide variety of viruses.

Sow. A mature female swine that has farrowed at least one litter.

Specific pathogen-free (SPF). Caesarian-born pigs or pigs taken from their dam and raised in isolation to control two specific diseases — atrophic rhinitis and mycoplasmic pneumonia. Both of these diseases are transferred from the dam to nursing piglets.

Sperm. The male gametocyte produced in the testis.

Spermatogenesis. The process of sperm production. Spermatogenesis depends upon the viability of the seminiferous tubules from which sperm cells develop. It occurs over a period of about seven weeks in boars.

Sperm-rich fraction. The portion of boar semen that contains the greatest concentration of sperm cells. See **Dilute fraction** and **Gel fraction.**

Steroids. Sex hormones, most of which are produced by the gonad. These include progesterone, testosterone, and estrogen.

Stress susceptibility. Pigs that exhibit symptoms of Porcine Stress Syndrome (PSS).

Superovulation. Causing the maturation and ovulation of more ova than would otherwise be normal for a female. The primary hormone used for superovulation is collected from pregnant mares, and causes the same physiological response in gilts and sows as LH and FSH.

Synchronization. Any treatment, hormonal or managerial, that causes a large percentage of females to come in estrus at the same time. Treating gilts with progesterone or synthetic progesterone compounds has been effective in preventing estrus. These females then come in estrus at about the same time after hormone treatment ceases. Moving gilts out of confinement, followed by exposure to a boar, also results in some synchronization of estrus in gilts that are near puberty.

"Teaser" Boar. A sterilized boar (usually by vasectomy) used to check estrous activity or to induce estrus in sows and gilts.

Testis. The primary reproductive gland of the male. The sex steroid testosterone and sperm cells are produced in the testis. See illustrations, pages 42-43.

Testosterone. The male sex hormone produced by interstitial (Leydig) cells in the testis. Testosterone is responsible for the development and function of the male reproductive tract, sperm production and maturation, the expression of secondary sex characteristics in males, and libido.

Urethra. The opening or tubelike structure for transportation of urine from the bladder to the penis in males or from the bladder to the vagina in females. See illustration, page 43.

Urethral orifice. Opening of the urinary duct from the bladder into the vagina. See illustration, page 43.

Uterine horn. The elongated portion of the uterus in female swine. The sow has two uterine horns, one connecting via the oviduct with each ovary. These horns, which constitute most of the uterus, can accommodate a large number of fetuses. See illustration, page 43.

Uterus. That portion of the female reproductive tract in which embryonic and fetal development occur. The uterine body, which is small, is the junction of the two uterine horns. See illustration, page 43.

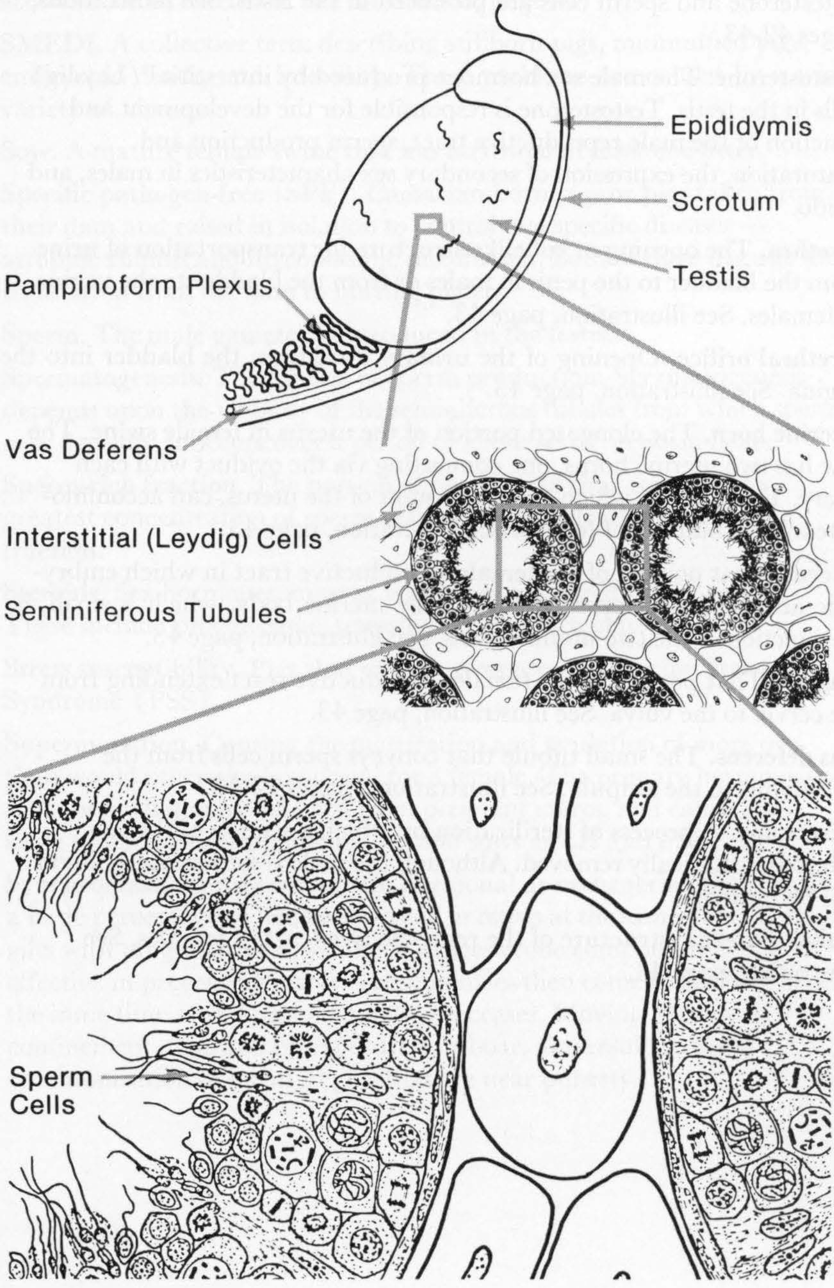
Vagina. That portion of the female reproductive tract extending from the cervix to the vulva. See illustration, page 43.

Vas deferens. The small tubule that conveys sperm cells from the epididymis to the ampula. See illustrations, pages 42-43.

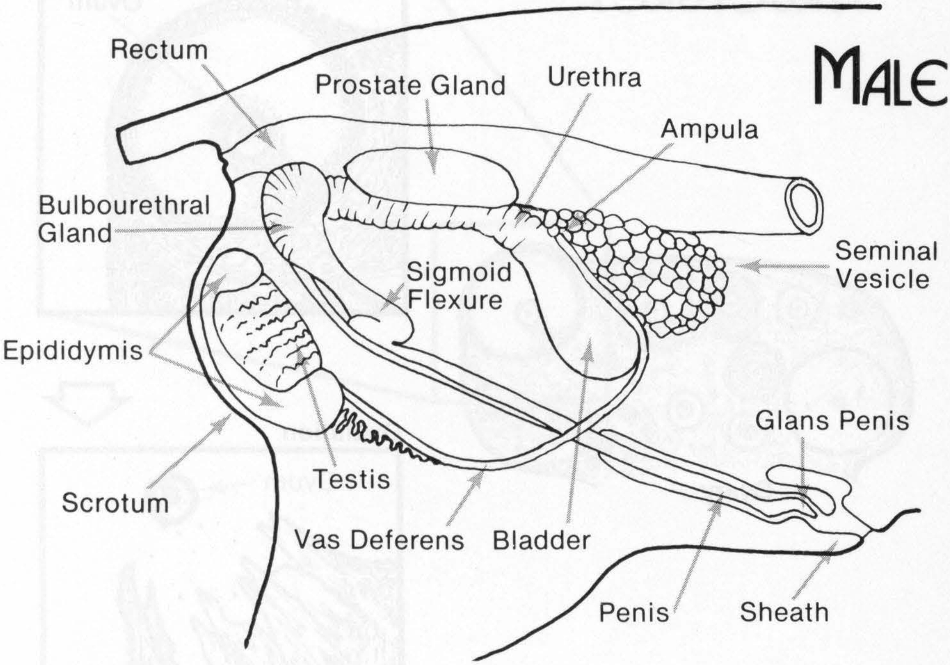
Vasectomy. A process of sterilization by which a section of the vas deferens is surgically removed. Although the male is sterilized, his libido will be normal.

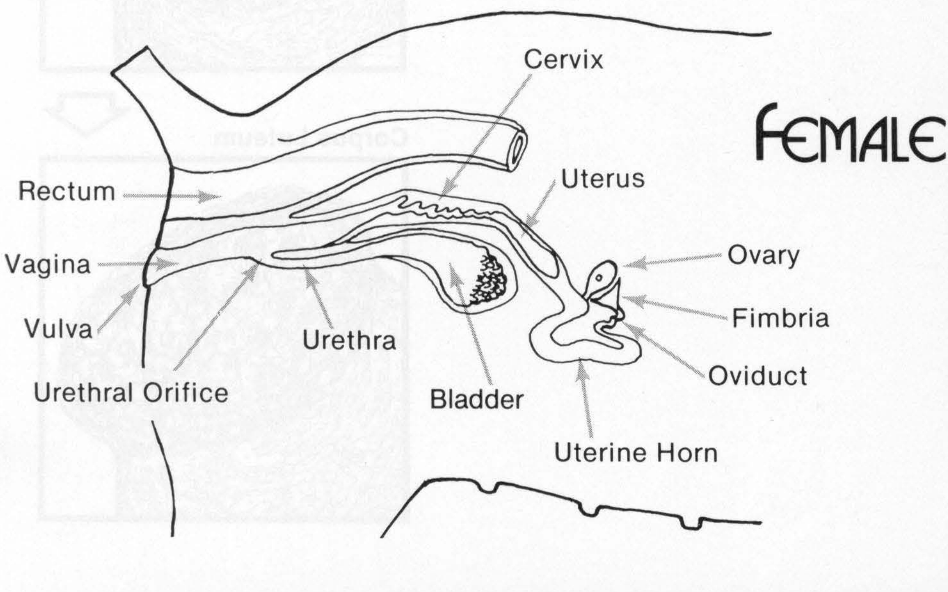
Vulva. External structure of the reproductive tract of females. See illustration, page 43.

Testis with Cell Types



SWINE REPRODUCTIVE SYSTEMS





Ovarian Structures